INSTRUCTION BOOK

99

DAWE INSTRUMENTS LIMITED

WESTERN AVENUE
ACTON. W.3.
TEL 01 992 67.. T

MISS WADSWORTH
CONFIRMS UNIT OBSOLETE
WAITING LETTER TO RON P.
CONFIRMING.

OPERATING INSTRUCTIONS
FOR

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U.L.F.
OSCILLATOR
TYPE 445

WESTERN AVENUE
ACTON. W.3

DAWE INSTRUMENTS LIMITED
HARLEQUIN AVENUE, GREAT WEST ROAD
BRENTFORD, MIDDLESEX
Telephone : ISLeworth 7331-5

Printed in U.K

NOVEMBER 1960

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1. SCHEDULE OF PARTS

The complete equipment comprises the following parts:—

1.1. One Instrument Type 445 fitted with the following valves:—

Seven EF91 (Mullard) or 6AM6 (Brimar).

One 85A2 (Mullard).

Two 150C4 (Mullard) or OA2.

Also:—

One Cartridge Fuse, Belling Lee L1055 1 A for 200–250 V operation, or 2 A for 110 V operation.

One Indicator Lamp 8 V 0·2 A M.E.S. cap (Vitality G541).

1.2. One Mains Lead complete with three-pin socket.

1.3. One Plastic Dust Cover.

1.4. One Instruction Book IB.445.

2. DESCRIPTION

2.1. Application

The U.L.F. Oscillator Type 445 is a precision grade instrument having an unusual degree of flexibility for measurements at sub-audio frequencies.

The wide frequency range and constant output level make the instrument ideal for measuring the frequency response characteristics of low frequency amplifiers used, for example, in geophysical and electro-medical research.

The rapid response of the automatic amplitude control circuit, combined with the ability to tune continuously from 0·01 c/s through subsonic and low audio frequencies up to 1,000 c/s is essential for vibration and strain investigations in machines and structures and for checking the response of low frequency recorders.

The oscillator provides two output signals in quadrature each of up to 15 V r.m.s. into a minimum load resistance of 10 kΩ.

A particularly useful accessory is the Variable Phase Adaptor Type 446, which provides three, four, six or eight phase balanced outputs and a continuously variable phase output from the quadrature input signals of the Type 445.

2.2. Design

The instrument employs a novel selective amplifier circuit with controlled positive feedback to maintain continuous oscillation. The circuit is a further development of the design covered by British Patent No. 781374 made under licence from the National Research Development Corporation.

The amplifier consists of a phase inverter followed by two integrating stages and is made selective by overall negative feedback. The positive feedback circuit includes a symmetrical diode limiter. The constant amplitude rectangular waveform from the limiter is applied to the input of the amplifier and due to the high selectivity the harmonic content of the output signal is reduced to negligible proportions.

The diode limiter provides a rapid automatic amplitude control effective down to the lowest frequency of 0·01 c/s. After a sudden transient for example, when changing ranges, the amplitude of oscillation is stabilized within about 3 cycles at all frequencies. This is a considerable advantage over the commonly employed thermal automatic amplitude control circuits which, in general, cannot be used at very low frequencies.

At the frequency of oscillation, each integrator provides a phase shift of very nearly 90°. Thus a quadrature output is made available after the first integrator stage.

The output impedance of each integrating stage is very low, so that the specified load impedance can be connected directly without affecting the performance of the oscillator.

The gain of the amplifier is virtually independent of valve characteristics and mains voltage variations. The negative d.c. feedback automatically sets all the valve stages to the proper operating conditions and the d.c. content in the output does not exceed 0·1 V over the entire frequency range after the initial warm up drift. The d.c. content can be set to zero for each output by pre-set potentiometers operated from the front panel.

Particular care has been taken with the mechanical design of the equipment to ensure maximum ventilation and as a result the thermal stability is very good. The natural flow of air passes in through a duct in the base of the cabinet and passes over the specially constructed chassis wall, cooling the components on its way up to the exit louvres at the top of the instrument.

3. INSTALLATION

3.1. Power Supply

Read the label attached to the instrument. For supplies other than that stated on the label it will be necessary to adjust the mains selector switch at the rear of the instrument. This is a screw driver adjustment accessible when the mains lead is unplugged.

With the MAINS switch in the off position, connect to the power supply by means of the mains lead provided:—

Red - - - - - -	Mains (Line)
Black - - - - -	Mains (Neutral)
Other Colour - - -	Earth

3.2. Valves

These are normally supplied fitted in their holders. The various types used are listed in Section 1.1.

4. OPERATION

4.1. Warm-up Period and Stability

Normally the instrument is ready for operation five minutes after switching on. This time is required for the heaters to warm-up and for the voltage to stabilise. However, when first put into operation or after standing idle for a long time, the instrument should run for 20–30 minutes.

On switching on from cold the output voltage is approximately 1·5% higher and the frequency is approximately 0·4% lower than the final stabilised values. The circuit stabilises to within about 0·5% in output voltage and 0·1% in frequency during the first 30 minutes of operation. A ±10% change in mains voltage results in approximately ±1·5% change in output voltage and ±0·01% in the frequency. The day to day stability is about ±0·5% in output voltage and ±0·01% in frequency.

4.2. Output

The output frequency is selected by the main FREQUENCY c/s dial and MULTIPLY BY range switch. The range switch indicates the multiplying factor to be used to obtain the frequency reading directly in c/s.

The maximum output voltage is 15 V for both 0° and −90° OUTPUTS.

Both output phases are fitted with a continuously variable potentiometer marked 0° AMPLITUDE and 90° AMPLITUDE respectively.

Note

The amplitude of the output voltage stabilises to approximately 90% of final value within the first 3 cycles of oscillation after a sudden change of operating conditions, for example when changing the range switch setting. Negligibly small delay is caused when the frequency dial is rotated slowly. Thus, when the quickest recovery time is required on the low frequency ranges it is best to switch to the range with frequency dial set to " 10 " and then rotate slowly to the required frequency.

4.3. D.C. Level

Provision is made for re-setting the d.c. level of each output if required as follows:—

Set the oscillator to 300 c/s and connect a 20,000 ohms/volt meter (e.g. Model 8 Avometer on the 10 V d.c. range) to the −90° OUTPUT and adjust the −90° D.C. LEVEL pre-set control until the d.c. level of the −90° output is zero (±0·1 V).

Similarly set the 0° output by means of the 0° D.C. LEVEL pre-set control and then check the −90° output again.

On the ×0·01 range of the MULTIPLY BY control an additional adjustment may be required to obtain zero d.c. level.

Set the oscillator to 0·03 c/s, connect a centre-zero d.c. microammeter with a suitable series resistor (not less than 10 kΩ) across the −90° OUTPUT and adjust R31, mounted internally on the wiring side of the chassis, until the deflection in the positive and negative direction are equal. Re-check the 0° OUTPUT and, if necessary, re-adjust the 0° D.C. LEVEL control.

5. MAINTENANCE

5.1. Removal of Instrument Side Covers

Disconnect the instrument from the mains supply before attempting to remove the covers. To gain access to the chassis proceed as follows:—

Unscrew the single 4BA chromium instrument head screw immediately above the DAWE nameplate at the bottom of both front and rear panels. Remove the metal bezels by grasping the bottom edge and pulling forward and upward. Grasp the top edge of one side cover and pull up and outwards to remove it completely. Similarly remove the other side. The valves and chassis components are then readily accessible.

5.2. Valves

The valves are standard commercial types and are not specially selected. However, if any valve is replaced the distortion of the output waveform should be checked. The distortion can be measured with an instrument which directly indicates the percentage distortion, such as the Dawe Type 700C Distortion Factor Meter. The total distortion over the measured frequency range of 20 c/s to 1,000 c/s is less than 0·5% for the 0° OUTPUT and less than 1·5% for the −90° OUTPUT into the rated 10 kΩ load resistance. The output voltage level and the d.c. content should also be checked. The setting of d.c. level is fully explained in Section 4.3. The maximum output voltage is set to 15 V into a load resistance not less than 10 kΩ for both outputs and the variation in the output does not exceed ±4% over the entire frequency range. The output voltage is best checked as follows:—

Run the instrument for 30 to 60 minutes. Connect an accurately calibrated direct-coupled oscilloscope to the 0° OUTPUT, set the 0° AMPLITUDE to maximum (i.e. fully clockwise), frequency dial to " 3 " and MULTIPLY BY switch to ×1·0 (i.e. 3 c/s).

Measure the peak-to-peak deflection on the screen 42·4 V and if necessary adjust the pre-set potentiometer R1 to give 42·4 V. R1 is located inside the instrument on a bracket on the wiring side of the chassis (see C10063). Set the MULTIPLY BY switch to $\times 10$ and $\times 100$ and adjust potentiometers R5 and R6 respectively to obtain the same peak-to-peak deflection on the screen. At these frequencies the calibration of the oscilloscope can be cross-checked with an accurate a.c. Valve Voltmeter to ensure 15 V r.m.s. output. On the $\times 100$ setting check that the output voltage with the frequency dial set to " 10 " (i.e. 1,000 c/s) is the same as on " 3." If necessary adjust the trimmer C1 located on the wiring side of the chassis close to the front panel and re-check the output with the dial set to " 3." Repeat this procedure until the correct 15 V output is obtained with the dial set to " 3 " and " 10."

Set the MULTIPLY BY switch to $\times 0{\cdot}1$ frequency dial to " 3 " and measure the peak-to-peak displacement on the screen. Allow sufficient time for the amplitude to stabilise after the switching surge. The amplitude builds up to about 90% of the final value within about 3 cycles of oscillation. During the next 5 cycles it normally exceeds the final value by about 5% and gradually stabilises within the next 5 to 10 cycles. When the amplitude has stabilised measure the peak-to-peak displacement if necessary, adjusting the pre-set potentiometer R3 to provide 42·4 V output. Set the MULTIPLY BY switch to $\times 0{\cdot}01$ and repeat the above procedure adjusting, if necessary, the pre-set potentiometer R2. Check that the amplitude is constant to within $\pm 4\%$ on all ranges and frequency dial settings.

6. SPECIFICATION

Frequency Range:	0·01 c/s to 1,000 c/s in five decades.
Calibration Accuracy:	±3% of scale reading. Scale hand-calibrated with an accuracy of ±1% on the 100 c/s to 1,000 c/s range.
0° Output	
Output Level:	15 V maximum continuously variable into a minimum load of 10 kΩ. Output level constant within ±4% over the entire frequency range.
Distortion:	Less than 0·5% total over the measured range 20 c/s to 1,000 c/s. Hum and noise less than 0·2%.
90° Output	
Phase Accuracy:	90° ±0·5° lagging referred to 0° output measured at 400 c/s.
Output Level:	15 V maximum continuously variable, into a minimum load of 10 kΩ. Maximum output within ±4% of 0° maximum output.
Distortion:	Less than 1·5% total over the measured range 20 c/s to 1,000 c/s. Hum and noise less than 0·2%.
Power Supply:	110 V and 200 to 250 V, 50–60 c/s, 50 W approx.
Mounting:	Light-weight portable metal cabinet finished black with polished metal bezels.
Dimensions:	8¼ in. × 13 in. × 12½ in. high (210 mm × 330 mm × 320 mm).
Weight:	20 lb. (9·1 kg.) approximately.

7. GUARANTEE

Our Products are carefully inspected and submitted to comprehensive tests at our factory before despatch. We therefore give to all purchasers (subject to the terms of payment and all the customer's other obligations being strictly observed) the following guarantee, which excludes and takes the place of any condition or warranty implied by Statute or otherwise.

If within three years from the date of despatch, any defect is discovered in any apparatus in respect of material or workmanship and reasonably within our control, we undertake to make good the defect at our own expense, provided notice is given to us as soon as it is discovered, and that the apparatus is immediately forwarded to our factory, carriage paid and with seals unbroken. Our responsibility is in all cases limited to the cost of making good the defect in the apparatus itself. This guarantee is given to our customers and does not extend to third parties, nor does it apply to defects caused by wear and tear, abnormal conditions of working, accident, misuse or neglect.

In the case of material or components not of our manufacture, we are prepared to give the customer the benefit of any guarantee given us in respect thereof.

8. SERVICING PROCEDURE

The information given in this booklet should enable the user to maintain the equipment in proper working order. If difficulties arise, please write or telephone our Service Department or our Representative or Agent for your area or country. In certain cases we may be able to arrange for an outside service engineer to call on you.

When contacting our Service Department please mention the serial and type numbers of your instrument and include a full report of the fault encountered, as well as details of the action taken to eliminate it.

This information should be addressed to:—

Service Department,
Dawe Instruments Ltd.,
7/9 Spur Road,
ISLEWORTH, Middlesex.
Telephone No. ISLeworth 8323.

If the equipment is returned for service, please include a copy of any relevant correspondence, together with all the accessories and the Instruction Book.

This procedure will facilitate the work of our Service Department and expedite the return of the instrument.

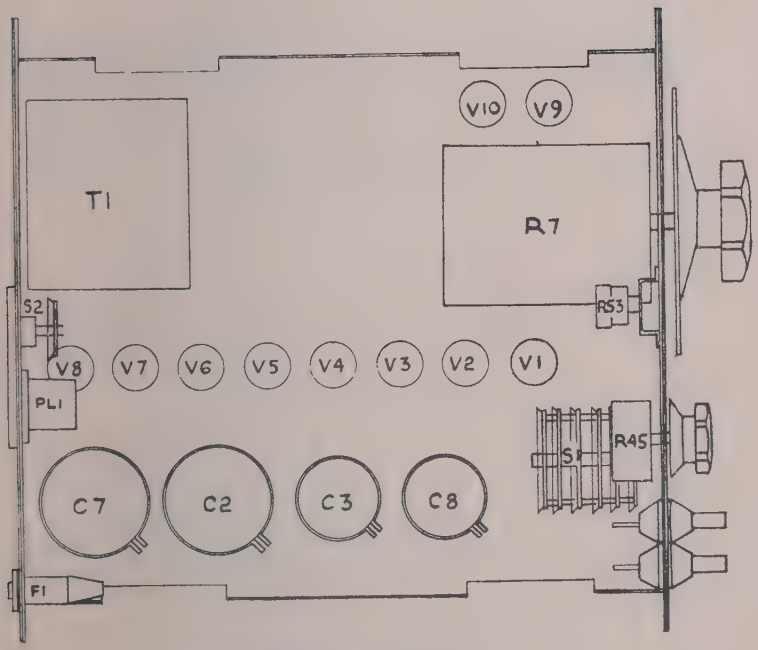
Circuit Ref.		RESISTORS	Tol.
R1	10 kΩ Pot.	Colvern Type 1106/9S	
R2	10 kΩ Pot.	Colvern Type 1106/9S	
R3	5 kΩ Pot.	Colvern Type 1106/9S	
R4	2·2 kΩ	Welwyn Type C22	±5%
R5	5 kΩ Pot.	Colvern Type 1106/9S	
R6	5 kΩ Pot.	Colvern Type 1106/9S	
R7	3 gang Pot.	155 kΩ Semi Log., 155 kΩ Semi Log., 1 kΩ Linear. Reliance	
R8	22 kΩ	Welwyn Type C23	±1%
R9	39 kΩ	Welwyn Type C22	±1%
R10	4·7 kΩ	Welwyn Type C22	±1%
R11	4·7 kΩ	Welwyn Type C22	±1%
R12	39 kΩ	Welwyn Type C22	±1%
R13	22 kΩ	Welwyn Type C23	±1%
R14	100 kΩ	Welwyn Type C22	±2%
R15	100 kΩ	Welwyn Type C22	±2%
R16	100 kΩ	Welwyn Type C22	±2%
R17	560 kΩ	Morganite Type S	±10%
R18	100 kΩ	Welwyn Type C22	±2%
R19	100 Ω	Morganite Type S	±10%
R20	270 kΩ	Morganite Type S	±10%
R21	100 kΩ	Morganite Type Y	±10%
R22	470 kΩ	Welwyn Type C22	±2%
R23	1 MΩ	Welwyn Type C22	±2%
R24	100 Ω	Morganite Type S	±10%
R25	5 kΩ Pot.	Colvern Type 1106/9S	
R26	20 kΩ	J.A. Jobling Type P3...	±5%
R27	27 kΩ	Welwyn Type C22	±1%
R28	3 kΩ	Welwyn Type C22	±1%
R29	3 kΩ	Welwyn Type C22	±5%
R30	330 Ω	Morganite Type S	±10%
R31	250 kΩ Pot.	Morganite Type U,' Lin. slotted, ½" spindle	
R32	330 kΩ	Morganite Type S	±10%
R33	100 Ω	Morganite Type S	±10%
R34	100 kΩ	Morganite Type Y	±10%
R35	12 kΩ	Welwyn Type C22	±5%
R36	1·2 kΩ	Welwyn Type C22	±5%
R37	470 kΩ	Welwyn Type C22	±2%

Circuit Ref.	RESISTORS		Tol.
R38	1 MΩ	Welwyn Type C22	±2%
R39	100 Ω	Morganite Type S	±10%
R40	27 kΩ	Welwyn Type C22	±1%
R41	3 kΩ	Welwyn Type C22	±1%
R42	20 kΩ	J.A. Jobling Type P3...	±5%
R43	3 kΩ	Welwyn Type C22	±5%
R44	330 Ω	Morganite Type S	±10%
R45	50 kΩ Pot.	Colvern Type 4001/15	
R46	100 Ω	Morganite Type S	±10%
R47	100 kΩ	Morganite Type Y	±10%
R48	15 kΩ	Welwyn Type C22	±5%
R49	22 kΩ	Welwyn Type C22	±5%
R50	33 kΩ	Welwyn Type C22	±5%
R51	47 kΩ	Welwyn Type C23	±5%
R52	68 kΩ	Welwyn Type C22	±5%
R53	5 kΩ Pot.	Colvern Type 1106/9S	
R54	22 kΩ	Morganite Type S	±10%
R55	100 Ω	Morganite Type S	±10%
R56	470 kΩ	Welwyn Type C22	±2%
R57	1 MΩ	Welwyn Type C22	±2%
R58	100 Ω	Morganite Type S	±10%
R59	10 kΩ	Welwyn Type C22	±5%
R60	680 kΩ	Welwyn Type C22	±5%
R61	20 kΩ	J.A. Jobling Type P3...	±5%
R62	50 kΩ Pot.	Colvern Type 4001/15	
R63	1·5 kΩ	Welwyn Type AW3115	±5%
R64	1·5 kΩ	Welwyn Type AW3115	±5%
R65	1·5 kΩ	Welwyn Type AW3115	±5%
R66	1·5 kΩ	Welwyn Type AW3115	±5%
R67	47 Ω	Morganite Type S	±10%
R68	47 Ω	Morganite Type S	±10%
R69	12 kΩ	Welwyn Type C22	±5%

Circuit Ref.			CAPACITORS	Wkg. Volts
C1	1·25–10 ρF		Wingrove & Rogers Type C32-01 ...	350
C2	10 μF	±1%	T.C.C. Type 30/4862	250
C3	1 μF	±1%	T.M.C. Type S113473QF	200
C4	0·1 μF	±1%	T.M.C. Type S125034	350
C5	0·01 μF	±1%	T.M.C. Type S125031	350
C6	0·001 μF	±10%	Dubilier Type S635	350
C7	10 μF	±1%	T.C.C. Type 30/4862	250
C8	1 μF	±1%	T.M.C. Type S113473QF	200
C9	0·1 μF	±1%	T.M.C. Type S125034	350
C10	0·01 μF	±1%	T.M.C. Type S125031	350
C11	0·1 μF	±25%	Hunts Type No. A306	250
C12	0·1 μF	±25%	Hunts Type No. A306	250
C13	32 μF		T.C.C. Type CE61LE, Sleeved... ...	350
C14	32 μF		T.C.C. Type CE61LE, Sleeved... ...	350
C15	30 μF		T.C.C. Type CE29L, Sleeved	350
C16	30 μF		T.C.C. Type CE29L, Sleeved	350
C17	33 ρF	±10%	Dubilier Type S635	350

Circuit Ref.	MISCELLANEOUS
S1	Oak Switch, N.S.F., D.I., Drg. No. C10,029
S2	Oak Switch, N.S.F., D.I., Drg. No. C9135
S3	C.H. Switch, N.S.F., 8370/K8
W1	Crystal Diode Type CV448
W2	Crystal Diode Type CV448
W3	Rectifier, Brimar Type C2D
W4	Rectifier, Brimar Type C2D
T1	Transformer, Partridge TD8265
PL1	Plug, Bulgin P73
F1	Fuse, 1 A, 200–240 V wkg., 2 A, 110 V wkg.
LP1	Pilot Lamp, Vitality, 8 V, 0·2 A, Type G541

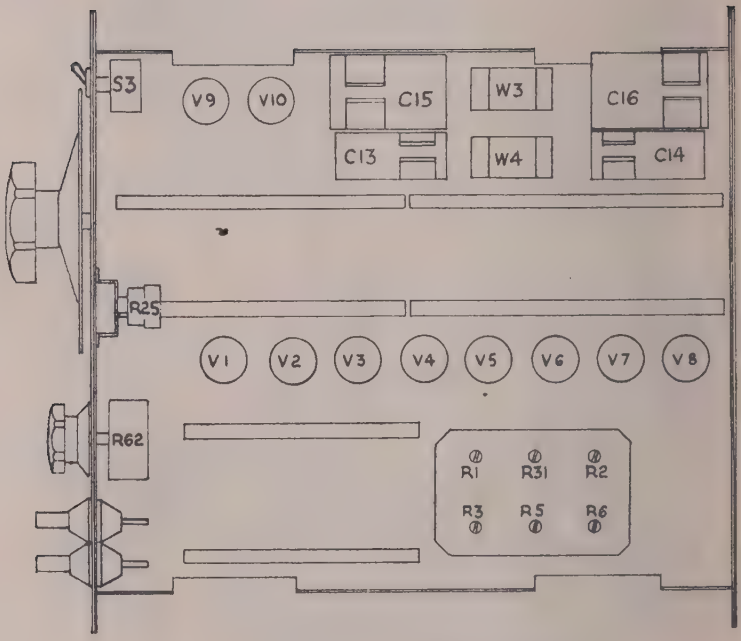
Circuit Ref.	VALVES
V1	85A2 Mullard
V2	EF91 Mullard or 6AM6 Brimar
V3	EF91 Mullard or 6AM6 Brimar
V4	EF91 Mullard or 6AM6 Brimar
V5	EF91 Mullard or 6AM6 Brimar
V6	EF91 Mullard or 6AM6 Brimar
V7	EF91 Mullard or 6AM6 Brimar
V8	EF91 Mullard or 6AM6 Brimar
V9	150C4 Mullard or OA2
V10	150C4 Mullard or OA2



SCHEMATIC LAYOUT OF MAJOR COMPONENTS (LEFT HAND)

C10062

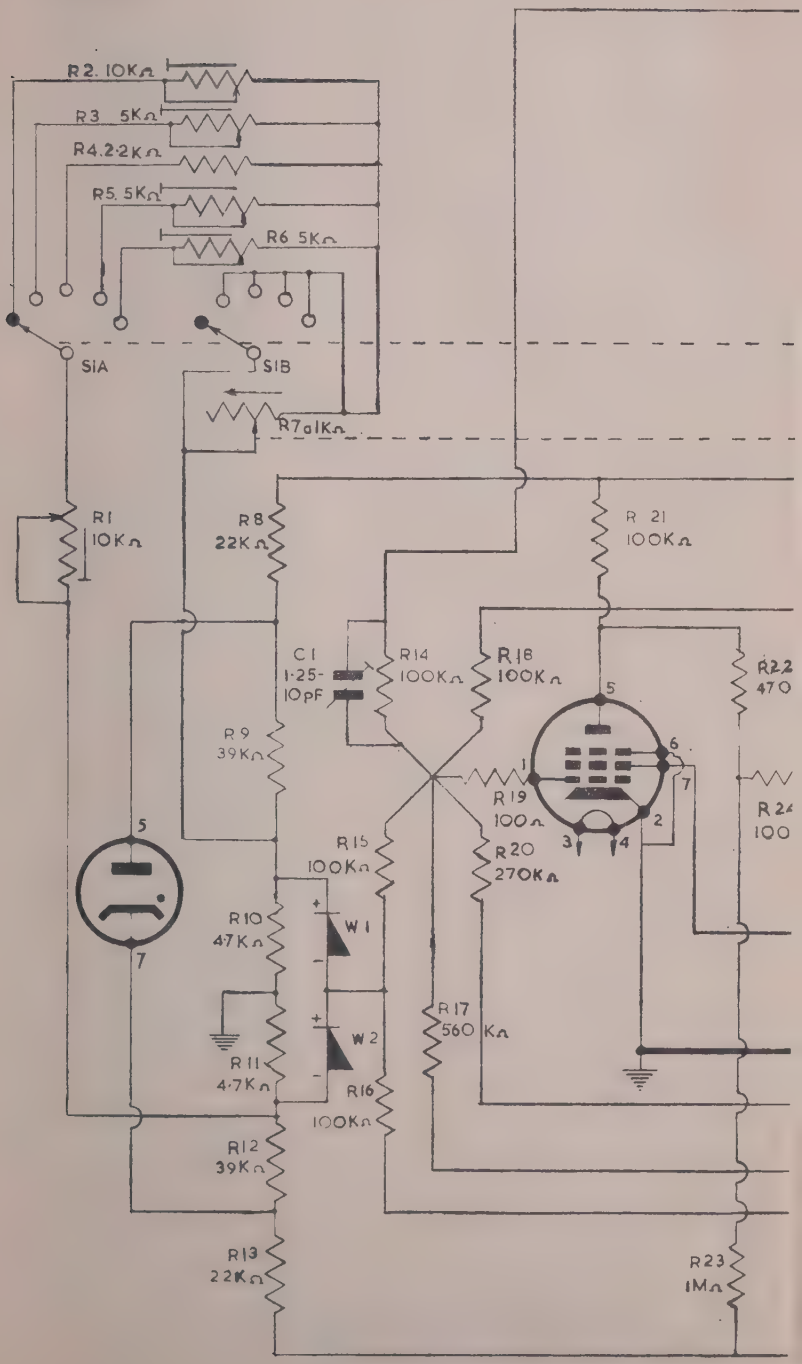
Fig. 1

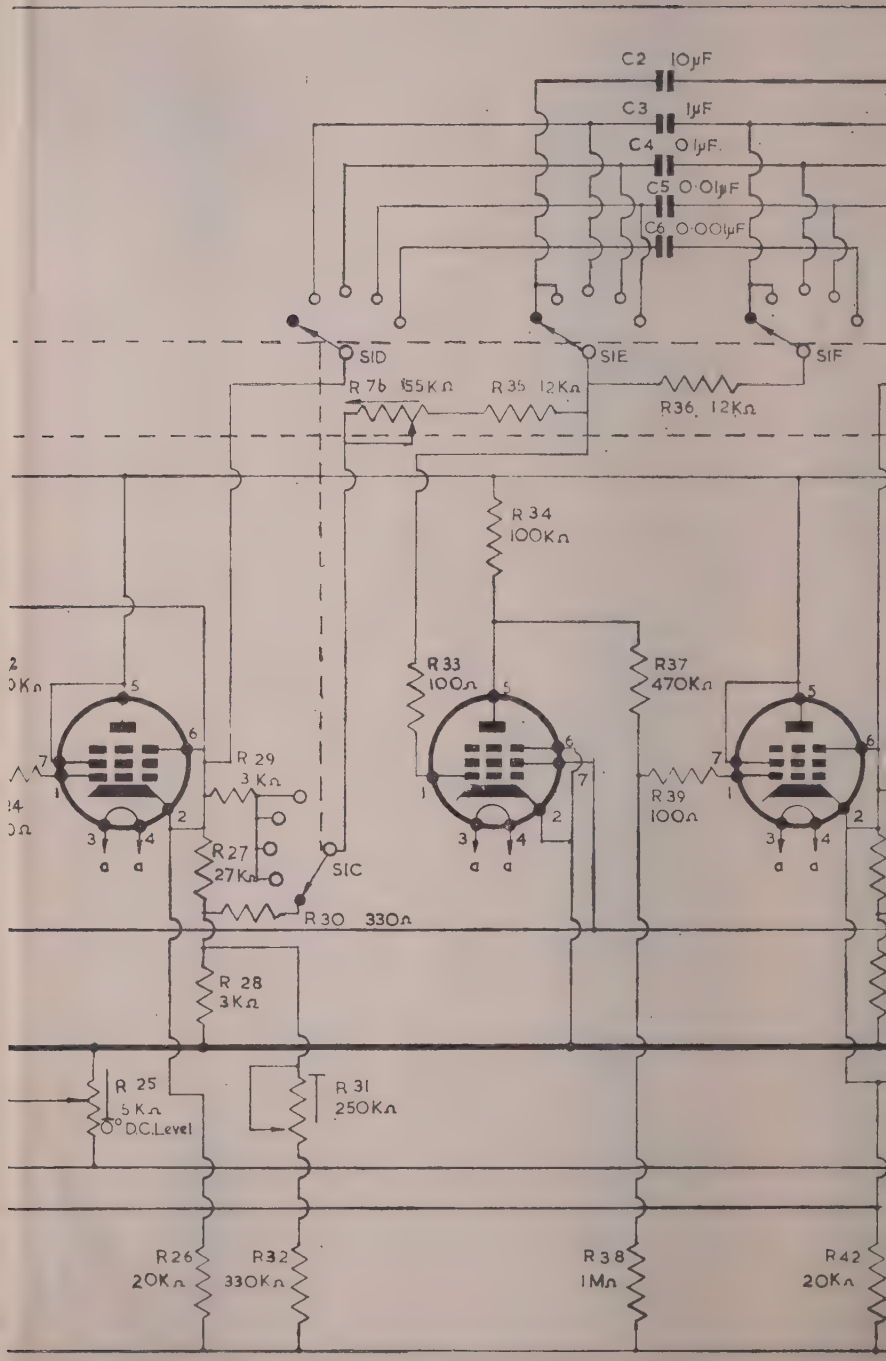


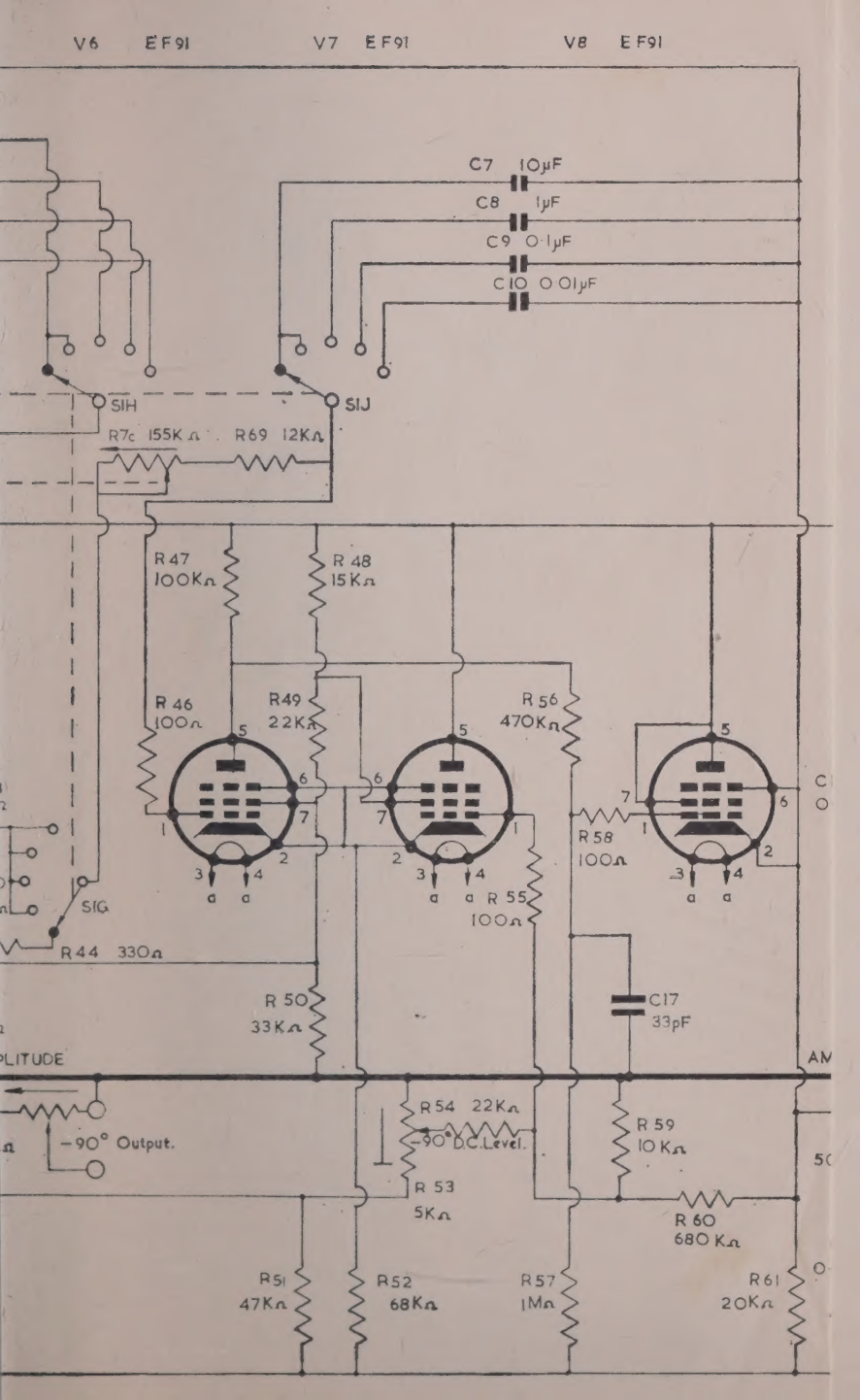
SCHEMATIC LAYOUT OF
MAJOR COMPONENTS
(RIGHT HAND)

C10063

Fig. 2


V1 85A2
V2 EF91
V
R2. 10KΩ
R3 5KΩ
R4.2·2KΩ
R5. 5KΩ
R6 5KΩ
S1A
S1B
R7 a1KΩ
R1 10KΩ
R8 22KΩ
R 21 100KΩ
C1 1·25-10pF
R14 100KΩ
R18 100KΩ
R22 470
R9 39KΩ
R19 100Ω
R 24 100
R15 100KΩ
R20 270KΩ
R10 47KΩ
W1
W2
R17 560 KΩ
R11 4·7KΩ
R16 100KΩ
R12 39KΩ
R13 22KΩ
R23 1MΩ


C2 10μF
C3 1μF
C4 0·1μF
C5 0·01μF
C6 0·001μF
SID
SIE
SIF
R 7b 155KΩ
R 35 12KΩ
R36 12KΩ
R 34
100KΩ
R 33
100Ω
R37
470KΩ
R 29
3 KΩ
R27
27KΩ
SIC
R30 330Ω
R 39
100Ω
R 28
3KΩ
R 25
5 KΩ
D.C.Level
R 31
250KΩ
R26
20KΩ
R32
330KΩ
R 38
1MΩ
R42
20KΩ


V6 EF91
V7 EF91
V8 EF91
C7 10μF
C8 1μF
C9 0·1μF
C10 0·01μF
S1H
S1J
R70 155KΩ
R69 12KΩ
R47 100KΩ
R48 15KΩ
R46 100Ω
R49 22KΩ
R56 470KΩ
R58 100Ω
R55 100Ω
S1G
R44 330Ω
R50 33KΩ
C17 33pF
-90° Output.
R54 22KΩ
90° D.C. Level.
R53 5KΩ
R59 10KΩ
R60 680KΩ
R51 47KΩ
R52 68KΩ
R57 1MΩ
R61 20KΩ

V9 150C4
V10 150C4

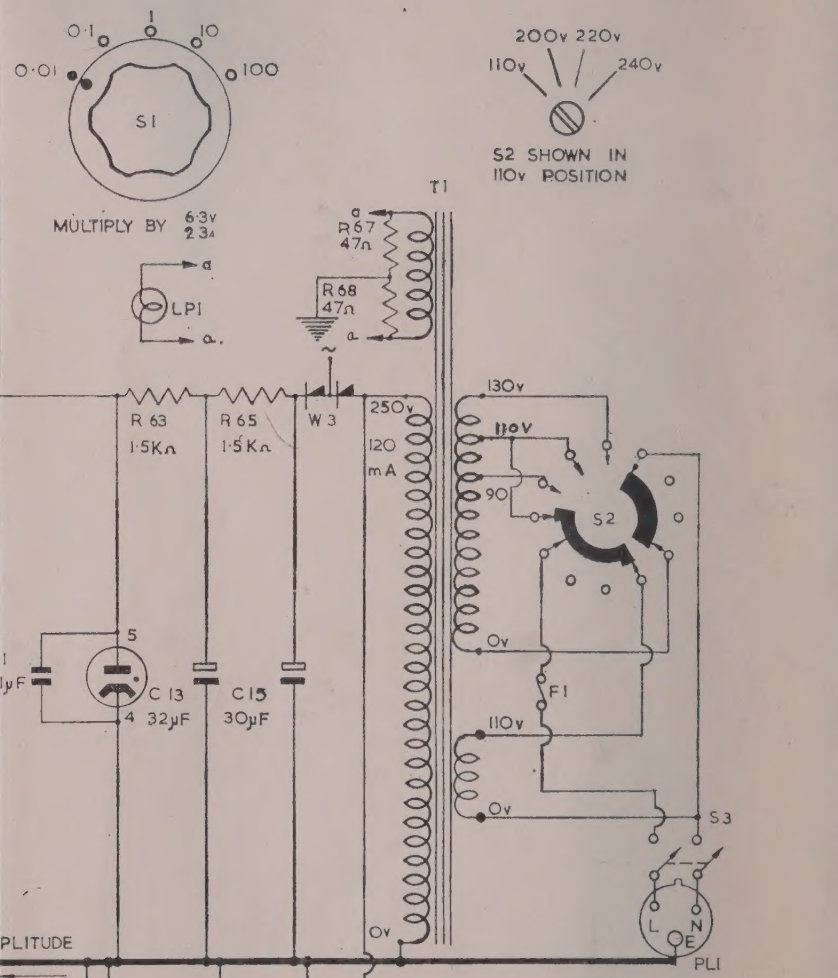


Fig 3 CIRCUIT DIAGRAM

E 8927

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